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Spectroscopic Behavior of Some He-Peculiar Stars

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Abstract. In this work we determine fundamental parameters (T_{eff} and $log\, g$) of a sample of He-peculiar stars from the continuum energy distribution around the Balmer discontinuity. Furthermore, we search for optical line variability in some recently discovered objects.

Introduction

He-weak and He-strong stars present abnormally weak or strong neutral helium lines when they are compared with their colors and MK spectral types determined from hydrogen and metal lines. The helium-peculiar stars also exhibit very strong variable magnetic fields ($\sim$ 1 KG) with typical periods of a few days (Bohlender et al. 1987; Borra et al. 1983). Their magnetic fields are variable with the same periods as their photometric and spectroscopic fluctuations. The variations are interpreted in terms of the Oblique Rotator Model in which the magnetic axis of a dipolar field is tilted at an angle β to the star's rotation axis. As the star rotates the orientation of the magnetic field relative to the observer changes, and the interaction of gravitational and radiative diffusion processes with the magnetic field gives rise to peculiar non-uniform abundances.

In this work we search for changes in line profiles related to rotational phase originated by the presence of an inhomogeneous distribution of chemical elements. We present here spectroscopic results of HD 135038, HD 142301 and HD 202671. We also determine fundamental parameters of a sample of He-peculiar stars which characterize the properties of the phostospheric layers.

Results and Discussion

Observations were carried out at Complejo Astronómico El Leoncito (CASLEO), San Juan, Argentina, with the 2,15 m telescope and the Boller & Chivens spectrograph during the nights of August 30 to September 3 and September 28 to 30, 2004. We obtained low resolution spectra with a 600 $\mathrm{l\,mm^{-1}}$ grating and a CCD of 512 $\times$ 512 pixels. Bias, flat field and spectrophotometric standard stars were also acquired to perform flux calibrated spectra. Another log of observations was taken with the REOSC échelle spectrograph in cross dispersion mode during eight nights (March 25 to 28 and June 17 to 20, 2005) covering the wavelength range 3500-5300 Å with a dispersion of 0.2 $\mathrm{Å\,mm^{-1}}$.

The spectral classification of the stars was derived considering the BCD spectrophotometric system (Barbier & Chalonge 1941; Chalonge & Divan 1952) which is based on direct measurable quantities of the Balmer discontinuity. D

measures the Balmer jump at λ3700 Å and it is a strong indicator of the effective temperature and λ_1 gives the mean spectral position of the Balmer jump and it is related to the surface gravity. The BCD parameters have the advantage that are not affected either by interstellar or circumstellar extinction. From the BCD parameters we can determine: T_{eff}, $log\, g$, M_V, M_{Bol} and the spectral type using the calibrations of (λ_1,D) given by Divan & Zorec (1982) and Zorec (1986). Our results are given in Table 1.

Table 1. Fundamental parameters derived from the BCD classification system

Star	$\lambda_1 - 3700$	D	$T_{\rm eff}$	$\log g$	TE	M_V	M_{Bol}
HD 5737	32.74	0.281	12700	2.95	B6 III	-2.5	-3.4
HD 19400	48.30	0.320	13000	3.9	B6-7 V	-0.8	-1.5
HD 37017	68.70	0.114	22500	4.22	B1-2 V	-2.0	-4.5
HD 37479	100.18	0.083	29000	4.2-4.3	B0 V	-2.0	-6.2
HD 49333	61.20	0.250	15800	4.23	B5 V	-0.7	-2.3
HD 49606	46.53	0.340	13500	3.80	B6 IV	-1.2	-2.0
HD 51688	49.98	0.340	12500	3.95	B7-8 IV	-0.6	-1.2
HD 64740	100.00	0.114	26000	4.25	B1 V	-1.7	-5.2
HD 142301	65.60	0.252	15700	4.30	B5 V	-0.7	-2.2
HD 142990	67.21	0.202	19000	4.27	B2-3 V	-1.2	-3.2
HD 144334	63.76	0.280	14500	4.30	B5-6 V	-0.4	-1.8
HD 144661	60.31	0.273	15000	4.23	B5 V	-0.5	-2.0
HD 144844	65.60	0.346	12100	4.32	B8 V	0.4	-0.8
HD 162374	51.11	0.247	15700	3.95	B5 V	-1.3	-2.7
HD 202671	44.37	0.303	13200	3.7	B6 IV	-1.4	-2.1

We also analyzed observations of three He-peculiar stars taken along eight nights with an échelle spectrograph. Table 2 summarizes the radial velocity and equivalent width measurements.

HD 135038 was classified as a helium-weak B8 III star (Wiegert & Garrison 1998). However, our determinations of equivalent widths of Hβ, Mg II λ 4481 and Si II λ 4128 suggest a B3 III-V spectral type. From the analysis of 16 spectra taken along 8 nights in two different epochs, we conclude that the star shows neither radial velocity nor equivalent widths variations (see Table 2). In contrast to the results of Wiegert & Garrison (1998) who found striking variations in Hγ, our results indicate that H lines show no significant variations.

HD 142301 is also a He-weak star that exhibits variations in the UBV photometric bands with a period of 1.45937 days (North 1984). We find that the star shows line radial velocity variations that range from -30 to 30 km s^{-1}, and displays slight intensity variations in most of the lines, with a period shorter than 1 day. No variations are detected in the equivalent widths of H lines.

We determine for this star a T_{eff} = 15,700 K and $log\, g$ = 4.3 (Table 1), these values agree with those obtained by Hunger & Groote (1999).

HD 202671 is a helium weak star. From the analysis of 11 spectra taken in June 2005, we find no significant variations in the line profiles of H, Mg II λ4481, and Si II $\lambda\lambda$4128,4130. Equivalent widths of He lines are not reliable since they are weak and blended with metal lines, thus they are not listed in Table 2.

Table 2. Measurements of equivalent widths and radial velocities

	HD 142301	**HD 135038**		**HD 202671**	
line	W(Å)	W(Å)	RV (km s^{-1})	W (Å)	RV (km s^{-1})
Hβ	4.07±0.62	4.42±0.44	-29.2±2.5	4.90±0.39	-8.5±3.3
Hγ	2.61±0.12	—	—	4.92±0.32	-11.5±1.4
Hδ	2.70±0.30	4.08±0.67	-29.5±6.5	5.17±0.36	-10.1±1.4
He I 4026	0.66±0.11	0.28±0.06	-33.3±9.3	—	-1.4±2.6
He I 4471	0.37±0.26	0.22±0.04	-31.1±3.6	—	-9.5±4.1
Mg II 4481	—	0.21±0.01	-30.0±2.1	0.20±0.01	-8.8±3.2
Si II 4128	0.13±0.01	0.15±0.02	-29.0±3.1	0.13±0.01	-7.7±4.0
Si II 4130	0.15±0.01	0.12±0.01	-28.0±4.1	0.11±0.01	-6.5±6.1

According to the BCD classification system its fundamental parameters are T_{eff}=13,200 K and $log\, g = 3.7$, values that are in good agreement with the ones obtained by Leone & Manfrè (1997) matching the Hβ line profiles.

It is remarkable that the gravities and effective temperatures we deduced from a direct observation of the parameters (λ_1,D) are in excellent agreement with effective temperatures deduced by integrating fluxes from IR to UV and gravities obtained from HIPPARCOS parallaxes together with tracks from stellar evolution (Groote 1982; Schaller et al. 1992).

In summary, we have found that HD 135038 and HD 202671 do not show any line variations and HD 142301 exhibits line intensity and radial velocity variations. The variations found in HD 142301 do not correlate with the magnetic period, 1.45937 days, and have a timescale of $\sim$ 20 hours. These variations could suggest the presence of non-radial pulsations. Further high resolution observations are needed to determine a precise period.

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